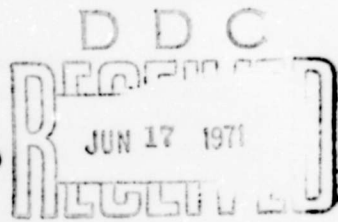


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Materiel Test Procedure 7-2-086
General Equipment Test Activity

U.S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

OXYGEN AND PROTECTIVE MASKS (AVIATION)



1. OBJECTIVE*

This document provides test methodology and testing techniques necessary to determine the technical performance and safety characteristics of aviation oxygen and protective masks and associated accessories as described in Materiel Needs (MN) and to determine the item suitability for service tests.

2. BACKGROUND

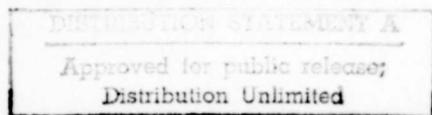
Requirements exist for Army aircraft pilot and crew member masks, which in conjunction with aircraft oxygen supply systems, protect the wearer against the hazards of a low oxygen content atmosphere and/or provide the airman with respiratory protection during and following the transport, application, or inadvertent exposure to chemical agents and munitions or smoke.

Currently, the requirements cited above are satisfied by similar, but separate, masks; however, at least one present day mask system is suitable for NBC missions and can be quickly adapted to serve as a conventional oxygen mask where missions require or circumstances dictate high altitude operations and aircraft components include the necessary oxygen supply system. Therefore, future requirements for dual purpose masks can be expected since Army flight operations are generally restricted to tactical support, NBC, and aerial observation missions conducted at altitudes considerably less than fifteen thousand feet. On the other hand, the Army inventory will probably contain for some time to come aircraft capable of attaining altitudes at which the use of oxygen is required on or is desirable, establishing the dual mask system as an effective alternate solution for both requirements.

Army aviation masks are described below to illustrate the scope of the present day requirements and to indicate possible trends for future requirements.

*This MTP is intended to be used as a basic guide in preparing actual test plans for the oxygen and protective masks. Specific criteria and test procedures must be determined only after careful appraisal of pertinent MN and any other applicable documents.

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1. Aviation Demand Oxygen Masks: This type of mask is used to dispense gaseous oxygen from demand regulators to the crew members of Army aircraft such as the CV-2, OV-1, U-8, and other craft containing high pressure oxygen systems. This type of mask does not require removal of the protective helmet when its use is required, and the mask contains a built-in microphone for communications purposes.

2. Aviation Protective Masks: These masks are used to provide aircraft pilots and crew members with respiratory protection in flight and on the ground whenever aircraft are used to disseminate chemical agents and munitions. Major components include a facepiece, filter canister, carrier, antidim set, and antiglare eyelens outsert(s). See Appendix A for a listing of the types of common chemical agents used by the Army and the degree of protection required during their use.

3. Combination Oxygen and Protective Mask: Masks of this type provide for the mission requirements described by 1 and 2 above. Essentially, these masks consist of the basic aviation protective mask and a kit which can be used to adapt the mask for direct connection to aircraft oxygen supply systems.

3. REQUIRED EQUIPMENT

3.1 GENERAL EQUIPMENT

- a. Measuring tape, ruler, and caliper.
- b. Weighing scale.
- c. Photographic equipment.
- d. Stop watch.

3.2 SPECIAL EQUIPMENT

- a. Gas mask leakage tester.
- b. Outlet valve leakage indicator.
- c. Inlet and outlet valve resistance indicator.
- d. Human head facsimile(s) (large, small, medium).
- e. Aircraft type intercommunications set.
- f. Aircraft noise simulator(s).
- g. Visibility test fixture (See Figure 2).
- h. Fungus spore cultures, as required.
- i. Communications test equipment required by MTP 6-2-195.

3.3 ENVIRONMENTAL AND CLIMATIC TEST FACILITIES

- a. High temperature test chamber.
- b. Low temperature test chamber and wind generator.
- c. Mold chamber.
- d. Radiant energy chamber (Sunshine Test).

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REFERENCES

- A. USAMC Pamphlet 706-134 Engineering Design Handbook: Maintainability Guide for Design.
- B. USATECOM Regulation 385-6 Safety: Verification of Safety of Materiel During Testing.
- C. USATECOM Regulation 700-1 Value Engineering.
- D. USATECOM Regulation 750-15 Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- E. Human Engineering Laboratories HEL Standard S-3-65.
- F. USAGETA Document Human Factors Evaluation Data for General Equipment (HEDGE)
- G. FED-STD-601 Rubber; Sampling and Testing.
- H. FED-STD-406 Plastics: Methods of Testing.
- I. MIL-O-27210 Oxygen, Aviator's Breathing, Liquid and Gas.
- J. MIL-P-5425 Plastic, Sheet, Acrylic, Heat Resistant.
- K. MIL-E-5272C Environmental Testing, Aeronautical and Associated Equipment, General Specification for.
- L. MTP 10-2-500 Physical Characteristics.
- M. MTP 102-501 Operator Training and Familiarization.
- N. MTP 10-2-502 Durability.
- O. MTP 10-2-503 Transportability.
- P. MTP 10-2-505 Human Factors Evaluation.
- Q. MTP 10-2-507 Maintenance Evaluation.
- R. MTP 10-2-508 Safety.
- S. MTP 10-2-511 Quality Assurance.
- T. MTP 10-2-512 Reliability.
- U. American Society for Testing Materials Document American Society for Testing Materials Standard.

5.

SCOPE

5.1

SUMMARY

This procedure describes the preparation for and methods of evaluating the technical characteristics of aviation oxygen and protective masks and their suitability for service testing. The required tests are summarized as follows:

a. **Preparation for Test** - A determination of the condition and physical characteristics of the test item upon arrival. Also, to ensure that the test item is complete and functionally operational, and to provide operator training and familiarization procedures.

b. **Leakage Tests** - A series of tests to determine the leakage characteristics of various test item components under ambient conditions.

c. **Inspiratory and Expiratory Resistance Test** - A test to determine test item inspiratory and expiratory resistance when subjected

to simulated human respiration under ambient conditions.

d. Subjective Tests - A series of tests to determine those test item characteristics which, if objectionable, could render the test unsatisfactory for human usage.

e. Environmental Effects Evaluation - A series of tests to determine test item capability to resist physical damage and to function as intended during or following exposure to accelerated climatic and environmental conditions.

f. Durability - An evaluation of the test item ability to retain original physical and performance characteristics after periods of extended operation.

g. Transportability - An evaluation to determine the ability of the test item in its shipping configuration to withstand the forces which it will experience during normal handling and transporting.

h. Maintenance and Reliability Evaluation - An evaluation to determine and appraise the maintenance characteristics and requirements of the test item, a verification and appraisal of its malfunctions, an evaluation of the test item associated publications and other common and special support elements (maintenance test package), an appraisal of the test item design for maintainability (AMCP 706-134: accessibility, ease of maintenance, standardization, and interchangeability), an evaluation of component and system durability and reliability, and the calculation of indicators which express the effects of the preceding aspects.

i. Safety - An evaluation to determine the safety characteristics and possible hazards of the test item.

j. Human Factors - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria.

k. Value Analysis - An evaluation directed at analyzing the primary function of the test item for the purpose of cost reduction without compromising performance, reliability, quality, maintainability or safety.

l. Quality Assurance - A review to determine and evaluate defects in material and workmanship.

5.2. LIMITATIONS

None.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

Upon receipt of the test item at the test site, perform applicable procedures of MTP 10-2-500 and the following:

a. Visually inspect the packaged test item. Record the following:

- 1) Evidence of damage incurred during transport or storage.
- 2) Exterior identification markings not in accordance with MIL-STD-129 or other governing documents.

b. Unpack and remove all traces of protective transport/storage materials. When this has been accomplished, visually inspect the test item. Record evidence of the following:

- 1) Interior marking(s) of shipment not in accordance with MIL-STD-129 or other governing documents.
- 2) Material imperfections, such as foreign matter, embedded in molded or formed components.
- 3) Surface flaws or evidence of component misalignment.
- 4) Missing, malformed, or fractured component(s).
- 5) Functioning parts which can be operated only with difficulty.

6.1.2 Inventory Check

a. Conduct an inventory against the Basic Issue Items List (BTIL). Record evidence of the following:

- 1) Missing maintenance literature or draft technical manuals.
- 2) Shortages in repair parts, accessories, or tools.
- 3) Missing kits.

b. Submit an Equipment Performance Report (EPR) for each noted shortage or discrepancy.

6.1.3 Inspection and Preliminary Operation

a. Perform preliminary operations/inspections and/or adjustments in accordance with the draft technical manual.

b. Ensure that the test item is thoroughly clean. Lenses should be cleaned, on both sides, with lens tissue or a clean, lint-free cloth.

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c. Examine test item nomenclature, warning, and instructional data plates or patches for conformance with MIL-STD-130 and other governing documents. Record evidence of errors and/or missing plates.

d. Disassemble the test item and examine major test item components according to the checklist below:

- 1) Elastomer components should be certified to be of ozone resistant composition as determined by tests conducted in accordance with the American Society for Testing Materials Standard, D1149, Procedure(s), or equivalent.
- 2) Elastomer components should not be more than twelve months old from the date of manufacture to the date of delivery to the Army.
- 3) Accessories, such as suspension devices, should bear evidence of compliance with appropriate design criteria.
- 4) Nonmetallic materials used in construction should not be subject to corrosion or other adverse affects due to continued exposure to oxygen gas.

e. Where oxygen gas is required during 6.2 Performance Testing, gas conforming to MIL-O-27210 should be used.

f. Test item lens should be in conformance with requirements of MIL-P-5425 as related to optical uniformity.

6.1.4

Physical Characteristics

a. Perform the dimensional and physical specification procedures of MTP 10-2-500. Record data as required by individual procedures.

b. Determine and record test item resin component physical properties listed below in accordance with the indicated FED-STD-406 test methods.

- 1) Tensile strength (Method 1011).
- 2) Compressive strength (Method 1021).
- 3) Flexural strength (Method 1031).
- 4) Izod impact strength (Method 1071).
- 5) Visible light transmission (Method 3022).
- 6) Index of refraction (Method 3011).
- 7) Linear thermal expansion (Method 2032).
- 8) Heat distortion (Method 2011).
- 9) Rate of burning (Method 7031).
- 10) Craze resistance under stress (Method 3053).

c. Determine and record test item elastomer component physical properties listed below in accordance with the indicated FED-STD-601 test methods.

- 1) Modules (100% elongation) (Method 4131).
- 2) Tear resistance (Method 4211).
- 3) Tensile strength (Method 4111).
- 4) Ultimate elongation (Method 4121).
- 5) Hardness (Method 3021).
- 6) Tension set (Method 4411).

6.1.5

Operator Training and Familiarization

Test personnel shall receive training and familiarization in accordance with applicable procedures of MTP 10-2-501 and the following:

a. Instruct all test personnel in test item operation and maintenance. Stress safety precautions to be observed when operating, maintaining, or repairing the test item and associated equipment.

b. Copies of the draft or preliminary technical manual and written safety instructions will be issued to each test team member.

c. Familiarize the test team concerning the purpose and methods required to test aviation oxygen and protective masks. The following topics should be stressed during these familiarization sessions.

- 1) Sequence of Tests and Adjustment: Tests and adjustments should be carried out in the specified order so that factors affecting each test will have been established and retesting and readjustment will be reduced or eliminated.
- 2) Test Equipment: Ensure that each team member understands the requirement for each specified test equipment and test fixture.
- 3) Terminology: Familiarize team members with trade terms and unique state-of-the-art terminology not otherwise defined in the supplied instructional matter.
- 4) Hazards: Review all hazards and safety precautions associated with operating, maintaining, and testing the test item.

d. Assess the value of the training and familiarization. Personnel who do not demonstrate adequate understanding of the material presented shall receive additional instruction. Record the name, rank, past experience, and degree of retraining required.

e. Prior to official testing, the various test apparatus should be operated by applicable team members for the purpose of familiarization with the test procedures and to verify satisfactory performance of each test setup. Test director evaluation of test personnel as a team should be recorded at the completion of this step.

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f. Record rank, unit, experience, and previous training for each team member. Also, record the adequacy of the supplied technical manuals for training purposes.

6.2

TEST CONDUCT

NOTE: Prepare an Equipment Performance Report for all equipment malfunctions.

6.2.1

Leakage Tests

a. Obtain facsimiles of the human head which represent HEL Standard S-3-65 anthropometric data. The human head dimensional simulator(s) should contain openings and internal tubing as illustrated by Figure 1.

b. Fit the test item to the head facsimile taking care to adjust and fasten straps, buckles, and side hooks to obtain a satisfactory facial fit and conditions which simulate service conditions. Record the type(s) and head form sizes used.

c. Connect a vacuum (suction) source to the head facsimile's internal tubing (see Figure 1). Proceed as follows:

- 1) Increase the suction pressure from zero centimeters of water to one centimeter of water. Maintain this pressure for a minimum of one minute.
- 2) Increase the suction as described in 1 above to a maximum of five centimeters of water in one centimeter increments.
- 3) Measure and record mask leakage at each pressure increment.

NOTE: For the leakage measurement required by a above, use the Edgewood Arsenal type M14 Gas Mask Leakage Tester, or equivalent.

d. Repeat procedures b and c for each available test item size, i.e., small, medium, large, etc. Use head facsimiles in accordance with a above.

e. Orient the mask to a position which will cause minimum valve leakage.

f. Apply suction within the mask so as to encompass the exhaust valve and the mask adjacent to the valve.

g. Vary the suction from zero to five centimeters of water in one centimeter increments.

h. Measure the leakage between the valve and mask for a minimum duration of one minute at each pressure increment. Record the value(s) of leakage at each pressure increment.

NOTE: For the leakage measurements required by h, use the Edgewood Arsenal type, M4A1 Outlet Valve Leakage Indicator, or equivalent.

i. Close off one end of the test item delivery hose and pressurize the hose to a minimum of three pounds per square inch.

j. Submerge the pressurized hose in a suitable tank of water and maintain the specified pressure. Beginning one minute following submersion, observe the hose for indication of bubbles rising from the hose. Record results of this test.

6.2.2 Inspiratory and Expiratory Resistance Test

a. Fit the test item to a head facsimile as described in 6.2.1a.

b. Connect appropriate instrumentation to head facsimile pressure connections for measuring pressure, rate of flow, and flow resistance.

NOTE: For the measurements required by b above, use the Edgewood Arsenal type Q106 Inlet and Outlet Valve Resistance Indicator, or equivalent.

c. Subject the test item to a gas flow in the direction of normal respiration. Where requirements do not exist to the contrary, maintain this gas flow at a rate of seventy liters per minute.

d. Measure and record the inspiratory and expiratory flow resistance under these conditions.

6.2.3 Subjective Tests

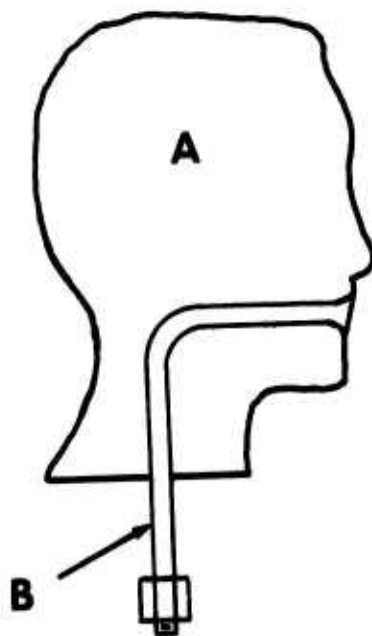
NOTE: The tests of this procedure should be conducted in conjunction with 6.2.10, Human Factors Evaluation.

6.2.3.1 Visibility Test

a. Obtain or construct a test fixture for visibility testing of masks containing eye lenses or other features which may interfere with normal vision. See Figure 2.

b. Fit the test item to a test subject possessing normal visual acuity. Ensure a comfortable facial fit.

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A - Human Head Facsimile

B - Internal Tubing for Mask Leakage and Other Test
Requiring Simulated Facial Fit

FIGURE 1. HEAD FACSIMILE, INSTRUMENTATION THEREOF

c. Seat the test subject in the visibility tester and instruct the subject as follows:

- 1) Prior to each subtest, the subject should position his eyes to align the two across hair sets.

NOTE: The purpose of the cross hair alignment prior to each visibility test is to ensure that the head is accurately positioned and level prior to recording visibility limits with a given test item.

- 2) When the test subject has achieved alignment of his head, he should move only his eyes in the direction instructed. Head movement will, of course, void the test.

d. Position the visibility tester arc (see Figure 2) to each of the angular positions indicated below. The test subject is to determine whether or not the arc can be seen by moving only his eyes.

- 1) Up 0 degrees.
- 2) Up 30 degrees.
- 3) Up 60 degrees.
- 4) Side 90 degrees.
- 5) Side 120 degrees.
- 6) Side 150 degrees.
- 7) Down 165 degrees.

e. Repeat the procedures above for each of six subjects, minimum. Record the resulting visibility data.

6.2.3.2

Odor Test

a. The test item shall be fitted to the face of six test subjects in a manner which provides a good facial fit and prevents exterior odors from influencing the test.

b. Each subject should wear the test item for a minimum of five minutes while breathing normally through the mask. Record actual values.

c. Test subjects should be instructed not to discuss opinions concerning mask odor with other test subjects.

d. At the end of the test period, each test subject should be questioned privately for his opinion of whether or not the test item emitted objectionable odor(s). The opinion and additional remarks shall be recorded.

6.2.3.3 Sizing and Fitting

Determine proper fitting of each test item type as follows:

NOTE: Sizing and fitting considerations are of particular importance, since aviation protective and oxygen masks must properly fit a wide variety of head and facial sizes and permit the wearer maximum freedom of movement in the normally restricted spaces of various Army aircraft.

a. Select test subjects representative of the 5th, 50th, and 95th percentile personnel (head and facial dimensions).

b. Issue a test item to each test subject. Issue in accordance with the imprinted or labeled sizing.

c. Each test subject shall don, in proper sequence, the test item and the clothing and equipment required for the specified mission.

d. Each test subject shall vary all available adjustments in accordance to the draft technical manual to obtain the best possible fit.

e. Each test subject shall then perform required routine operational and mission-oriented tasks.

f. Rate each type test item for overall fit acceptability and task noninterference.

6.2.3.4 Donning and Removing

a. Prepare for evaluation as in paragraph 6.2.3.3, steps a and b.

b. Record any apparent difficulties observed during donning and/or removing.

c. Interview test subjects individually to determine their opinions regarding the ease and safety of donning and removing the test item with respect to the following, if applicable:

- 1) Suitability of fastenings and adjustments.
- 2) Ability to effect fastenings and adjustments.
- 3) Ease of donning and removing over clothing and other equipment.
- 4) Apparent difficulties observed by the recorder.

6.2.4 Environmental Effects Evaluation

The purpose of these tests is to determine test item capability to resist physical damage and to function as intended during or following exposure to accelerated climatic and environmental conditions simulated in accordance with MIL-E-5272, modified by these procedures.

6.2.4.1 Low Temperature Tests

6.2.4.1.1 Low Temperature Operation

a. Obtain the usage of a combination cold-type test chamber and wind generator of a physical size suitable for total containment of the test item fitted to a head facsimile as described by 6.2.2a and b. The chamber should be capable of reaching and maintaining a temperature of -45 degrees F. for four hours, minimum, while generating a wind velocity up to and including twenty miles per hour.

b. Install the test item as indicated by a above and provide the instrumentation required to measure pressure, rate of flow, and flow resistance during the low temperature test.

c. Lower the temperature to -65 ± 2 degrees F. Record actual values.

d. When test item temperature stability is attained, initiate wind generator operation, maintaining a wind speed across the test item of fifteen miles per hour, or as otherwise specified. Record actual values.

e. Maintain the conditions specified by d above and subject the test item to oxygen flow rates representative of the normal respiration of an adult for three hours, minimum. Measure and record expiratory and inspiratory resistance throughout the three-hour period.

6.2.4.1.2 Low Temperature Starting Delay and Exhalation Port Icing Tests

a. Subject the test item to a temperature of -40 ± 2 degrees F. for a minimum duration of two hours. The mask shall not be used or moved during the specified period.

b. Remove the mask from the cold type chamber and immediately place in operation in accordance with the draft technical manual. Record whether or not the mask functioned as specified by design performance requirements. Also, record, if applicable, the time delay prior to proper mask operation.

c. Subject the mask to normal respiration while exposed to atmospheric conditions that will cause water to collect in the exhalation port and channel.

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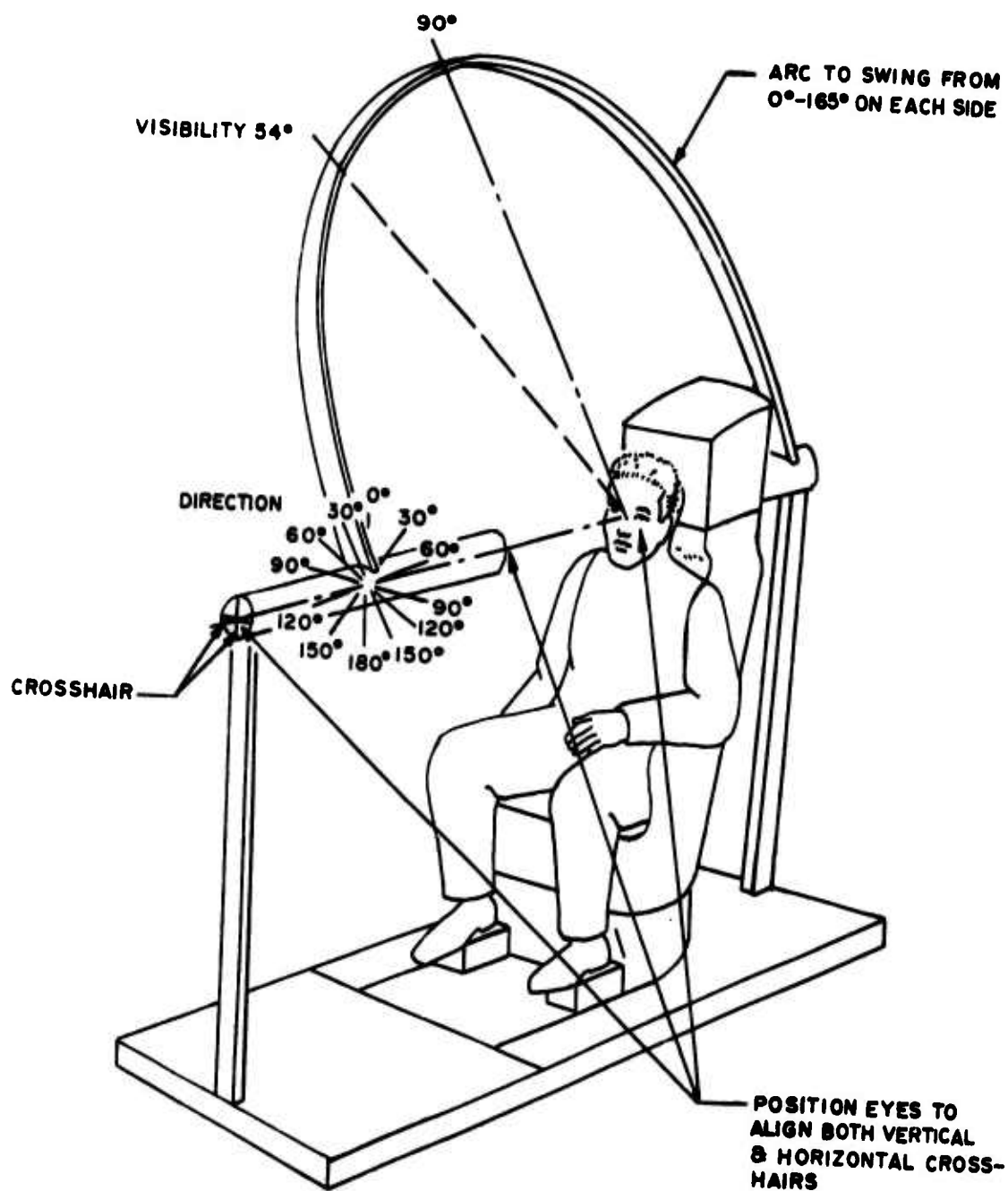


Figure 2. Method of Determining Test Item Visibility (ILLUSTRATED)

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d. Immediately following the generation of respiratory moisture in the test item port and channel, place the test item in the cold chamber set to a temperature which will cause the moisture to freeze. Record actual values.

e. When the test item port and channel water is completely frozen, remove the test item and manually massage and manipulate to remove formed ice.

f. Record the length of time required to free the test item of ice. Repeat the test a minimum of five times; use five different team members for removing formed ice following the moisture freezing part of the procedure.

6.2.4.1.3 Low Temperature Pliability Test

a. Place the test item in the cold test chamber and stabilize at a temperature of -65 ± 2 degrees F. Expose the test item to this low temperature for a period of one hour. Record actual values.

b. Remove the test item from the chamber. Massage, manipulate, or otherwise subject the test item to usage which would indicate an increase in mask assembly rigidity. Record evidence of an apparent increase in rigidity or loss of pliability.

6.2.4.2 High Temperature Tests

6.2.4.2.1 High Temperature Operation

a. Obtain the usage of a heat chamber of a physical size suitable for total containment of the test item fitted to a head facsimile as described by 6.2.2.a and b. The chamber should be capable of attaining and maintaining a temperature of 212 degrees F. for not less than seventy-two hours.

b. Install the test item as indicated by a above and provide the instrumentation required to measure pressure, rate of flow, and flow resistance during the high temperature test.

c. Raise the chamber temperature to 160 ± 2 degrees F. Record actual values.

d. Maintain the conditions specified by c above for a period of three hours and during that time subject the test item to oxygen flow rates representative of the normal respiration of an adult. Measure and record expiratory and inspiratory resistance throughout the three-hour period.

e. Subject the test item to 6.2.3.2, Odor Test. Record data as required.

6.2.4.2.2 High Temperature Storage Test

Place the mask and samples of elastomer parts in a heat chamber,

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excluding plastic parts, and raise the temperature to 212 degrees F. Maintain this condition for a minimum period of seventy-two hours.

b. Remove the test item from the chamber. Massage, manipulate or otherwise subject the test item to usage which would indicate gummy or tacky areas caused by prolonged exposure to high temperatures. Also, determine that the mask operates as intended by retesting to 6.2.1, 6.2.2, and 6.2.3. Record test results as required.

6.2.4.3 Accelerated Aging Tests

At the completion of 6.2.4.2, High Temperature Storage Test, subject the elastomer component samples to the specified methods of FED-STD-601:

- a. Tensile strength, percent loss (Method 7221).
- b. Ultimate elongation, percent loss (Method 7221).
- c. Compression set (30 percent deflection), (Method 3311).
- d. Record the results of each FED-STD-601 test.

6.2.4.4 Fungus Resistance Test

Subject the test item to the 28-day fungus resistance test in accordance with Procedure I of MIL-E-5272. At the end of the test, test item parts should be examined visually and evidence of deterioration or other effects recorded. Performance tests 6.2.1, 6.2.2, and 6.2.3 should be repeated in their entirety.

6.2.4.5 Sunshine Test

Subject the test item and resin/elastomer samples to the 48-hour radiant energy test in accordance with Procedure I of MIL-E-5272. At the end of the test, test item parts should be examined visually and evidence of deterioration or other effects recorded. Subject samples of test item resin/elastomer parts to the physical properties tests of 6.1.4, Physical Characteristics. Subject the test item to complete retests according to the Procedures of 6.2.1, 6.2.2, and 6.2.3.

6.2.5 Microphone Tests

6.2.5.1 Microphone Electrical Characteristics Test

Determine test item microphone electrical characteristics of impedance, breakdown voltage, sensitivity, frequency response, and harmonic distortion.

6.2.5.2 Word Articulation Test

To determine the acoustic characteristics of the test item microphone which affect the distinct transmission of the human voice, perform word articulation tests in accordance with Office of Scientific Research and Development Report No. 3802. In conjunction with OSRDR Report No. 3802, the following conditions should be maintained for the test.

- a. A minimum of two talkers and five listeners should be employed for the test.
- b. Each test should include a sufficient number of words to assure that the resulting scores are statistically significant. Record actual values.

c. Articulation tests should be performed with an aircraft representative type of intercommunication set. Record the type used.

d. Test should be performed in the presence of turbo/conventional propeller-type aircraft noise having any level up to and including 120 db at ground level and at a simulated altitude of 15,000 feet. Record actual values.

6.2.6 Transportability

Evaluate the transportability characteristics of the oxygen and protective masks by accomplishing the applicable procedures of MTP 10-2-503. Record the test data.

6.2.7 Durability

The test item's durability shall be verified by performing the applicable procedures of MTP 10-2-502 and the following:

a. During accomplishment of testing as described by this document, the durability characteristics of the test item shall be observed. In the event of equipment failure during testing, maintenance and repair procedures shall be accomplished and the testing shall be continued.

b. Upon completion of all testing as described in this document, the test item shall be inspected for signs of excessive or accelerated wear and potential equipment failure.

c. Record data as required by MTP 10-2-502 and any indication of the following:

- 1) Fastening failure.
- 2) Loose or missing hardware.
- 3) Excessive wear.
- 4) Damage to any component, material or finish.

6.2.8 Maintenance and Reliability Evaluation

a. Evaluate and appraise the maintenance/reliability-related factors of the test item as described in MTP 10-2-507, MTP 10-2-512, and AMC Pamphlet 706-134 with emphasis on the following:

- 1) Organization (O), Direct Support (F), and General Support (H) maintenance requirements.
- 2) Operator through General Support Maintenance Literature.
- 3) Repair parts.
- 4) Tools.
- 5) Test and handling equipment.
- 6) Maintenance facilities.
- 7) Personnel skill requirements.
- 8) Maintainability.
- 9) Reliability.
- 10) Availability.

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b. Obtain the data required by Appendix B of USATECOM Regulation 750-15 to enable the calculations of those indicators which express the effects of the preceding aspects.

6.2.9 Safety

Provide a safety release recommendation in accordance with USATECOM Regulation 385-6 and observe all normal safety precautions governing the operation of the test item and test equipment. Perform applicable procedures of MTP 10-2-508. Record data required by that MTP and the following:

a. Any dangerous or unsafe condition or any condition that might present a safety hazard including the cause of the hazard. Record the steps taken to alleviate any such hazard.

b. The safety features incorporated into test item design.

c. Adequacy of warning instructions and markings.

d. Suggestions to improve the existing safety precautions.

6.2.10 Human Factors Evaluation

The test item shall be evaluated to determine the degree to which test item physical design and revealed performance characteristics conform to recognized human factors engineering design criteria. In order to facilitate this evaluation, prepare checklists of design criteria applicable to Class IV D material as defined by Human Factors Evaluation Data for General Equipment (HEDGE). Also, incorporate applicable procedures of MTP 10-2-505 and the following:

a. General considerations to be included in checklist:

1) Adequacy of item design for fitting, donning, and removing.

2) Adequacy of item design for the performance of routine tasks in conjunction with normal complement of gear.

3) Adequacy of item design for ease of preparing for use, to include:

a) Minor assembly or correction.

b) Allowing access to operating components.

c) Cleaning or changing necessary parts.

d) Replenishing of expendables such as CO₂ absorbents and O₂ generating chemicals.

e) Any other final preparations.

f) Adequacy of furnished instructions.

4) Personnel required for task.

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b. Area considerations to be included in checklists for all tests:

- 1) Fit and adjustment items.
- 2) Ease of controlling and adjusting test item as worn.

c. Include in the technical performance checklists revealed performance characteristics which did not conform to recognized human factors design criteria.

d. Subjective evaluation checklist to be completed by various test subjects and qualified observers.

- 1) Odor (objectionable or not).
- 2) Facial fit.
- 3) Comfort of item over long periods (3-4 hours.)
- 4) Restrictions on visibility.
- 5) Don/remove suitability.

e. Record any inadequacies of test item design affecting ease of use.

f. Record any recommendations to improve man-item effectiveness.

6.2.11 Value Analysis

Throughout all test, the test item shall be examined for any unnecessary, costly, "nice-to-have" features as described in USATECOM Regulation 700-1. Perform the following:

a. During operation of the test item, observe for features which could be eliminated without compromising performance, reliability, durability, or safety.

b. Question test personnel regarding features of the test item which could be eliminated without decreasing the functional value of the test item or decrease man-item effectiveness.

c. Record the following:

- 1) Nonfunctional, costly, or "nice-to-have" features of the test item.
- 2) Test personnel comments and opinions regarding features to be eliminated.

6.2.12 Quality Assurance

Throughout all tests, examine the test item for compliance with the quality requirements of the applicable MN and the provisions of MTP 10-2-511.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Initial Inspection

Record the following:

- a. Data required by applicable procedures of MTP 10-2-500.
- b. Evidence of damage incurred during transport or storage.
- c. Exterior identification markings not in accordance with MIL-STD-129 or other governing documents.
- d. Interior marking(s) of shipment not in accordance with MIL-STD-129 or other governing documents (following test item being unpacked).
- e. Evidence of defects in test item materials and construction, treatment and finish, and/or workmanship.

6.3.1.2 Inventory Check

Record the following data after an inventory conducted against the BIL.

- a. Missing maintenance literature or draft technical manuals.
- b. Shortages in repair parts, accessories, or tools (authorized tools).
- c. Missing kits.

6.3.1.3 Inspection and Preliminary Operation

Record the following:

- a. Evidence of errors in test item nomenclature, warning, instructional data plates/patches.
- b. Elastomer components not ozone resistant.
- c. Out-of-date test items.

6.3.1.4 Physical Characteristics

Record the following:

- a. Data required by applicable procedures of MTP 10-2-500.

b. Resin component physical properties:

- 1) Tensile strength, in p.s.i.
- 2) Compressive strength, in p.s.i.
- 3) Flexural strength, in p.s.i.
- 4) Izod impact strength, Ft. Lb. per in. of notch.
- 5) Visible light transmission, in percent.
- 6) Linear thermal expansion, coefficient per degree F.
- 7) Heat distortion, in degrees F.
- 8) Rate of burning, inches/minute.
- 9) Index of refraction, (ratio).
- 10) Craze resistance under stress, evidence of.

c. Elastomer component physical properties.

- 1) Tear resistance, lb./in.
- 2) Modulus, in p.s.i.
- 3) Ultimate elongation, percent.
- 4) Hardness.
- 5) Tension set, percent.

6.3.1.5

Operator Training and Familiarization

Record the following:

a. Data required by MTP 10-2-501.

b. For personnel requiring retraining.

- 1) Name.
- 2) Rank.
- 3) Past experience.
- 4) Degree of retraining required.
- 5) Adequacy of technical manual(s) for training purposes.

c. Test director evaluation of test personnel as a team.

d. For each team member:

- 1) Rank.
- 2) Unit.
- 3) Experience.
- 4) Previous training.

6.3.2

Test Conduct

6.3.2.1

Leakage Tests

Record the following:

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- a. Head facsimile type(s) used and sizes.
- b. Mask facial leakage at each pressure increment, medium size, in liters per minute.
- c. Mask facial leakage for each mask size.
- d. Valve leakage at each pressure increment, in liters per minute.
- e. Evidence of delivery hose leakage.

6.3.2.2

Inspiratory and Expiratory Resistance Test

Record the following:

- a. Type of inlet and outlet valve resistance indicator used.
- b. Respiratory rate established for test, in liters per minute.
- c. Inspiratory resistance, in centimeters of water.
- d. Expiratory flow resistance, in centimeters of water.

6.3.2.3

Subjective Tests

6.3.2.3.1

Visibility Test

Record the following:

- a. Visibility test fixture type used.
- b. Visibility for each angular position, in degrees, for each test subject.

6.3.2.3.2

Odor Test

Record the opinion of each test subject regarding acceptability of test item odor(s).

6.3.2.3.3

Sizing and Fitting

Record the following:

- a. Description of test subjects in regard to size.
- b. Acceptability of each test item type in regard to adjustments, facial fit, etc.

c. Evidence of interference with mission tasks.

6.3.2.3.4

Donning and Removing

Record the following:

- a. Difficulties observed during donning and/or removing.
- b. Test subject's opinions regarding ease and safety of donning and removing.

6.3.2.4

Environmental Effects Evaluation

6.3.2.4.1

Low Temperature Tests

6.3.2.4.1.1

Low Temperature Operation

Record the following:

- a. Type and capabilities of cold chamber used.
 - b. Value of temperature at which test was conducted, in degrees F.
 - c. Wind speed during test, in miles per hour.
 - d. Oxygen flow rate, in liter per minute.
 - e. Expiratory resistance, in centimeters of water.
 - f. Inspiratory resistance, in centimeters of water.
- 6.3.2.4.1.2
- Low Temperature Starting Delay and Exhalation Port Icing Tests
- Record the following:
- a. Value of temperature at which test was conducted, in degrees F.
 - b. Mask performance immediately following removal from test chamber.
 - c. Time delay until mask performed as intended, in seconds, minutes, etc.
 - d. Time required to free test item port and channel of formed ice.

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6.3.2.4.1.3 Low Temperature Pliability Test

Record the following:

a. Actual temperature at which test was conducted, in degrees F.

b. Time test item was exposed at test temperature, in hour.

c. Evidence of an apparent increase in test item rigidity or loss of pliability.

6.3.2.4.2 High Temperature Tests

6.3.2.4.2.1 High Temperature Operation

Record the following:

a. Type and description of heat chamber used.

b. Temperature at which test was conducted, in degrees F.

c. Oxygen flow rates, in liters per minute.

d. Expiratory and inspiratory resistance in centimeters of water.

e. Results of Odor Test, 6.3.2.3.2 following heat tests.

6.3.2.4.2.2 High Temperature Storage Tests

Record the following:

a. Temperature and length of time test was conducted, in degrees F. and hours.

b. Evidence that test item was gummy or tacky or other effects of storage at elevated temperatures.

6.3.2.4.3 Accelerated Aging Tests

Record the following:

a. Temperature and length of time test was conducted, in degrees F. and hours.

b. Physical properties (elastomer components) following aging test:

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- 1) Tensile strength, percent loss.
- 2) Ultimate elongation, percent loss.
- 3) Compression set, percent.

6.3.2.4.4 Fungus Resistance Test

Record the following:

- a. Data required by Procedure I of MIL-E-5272.
- b. Performance data following retest(s) to 6.2.1, 6.2.2,
and 6.2.3.

6.3.2.4.5 Sunshine Test

Record the following:

- a. Data required by Procedure I of MIL-E-5272.
- b. Performance data following retest(s) to 6.2.1, 6.2.2,
and 6.2.3.

6.3.2.5 Microphone Tests

Record the following:

- a. Word count used in word articulation test.
- b. Type of aircraft intercommunications set used.
- c. Aircraft altitudes and noise levels simulated.

6.3.2.6 Transportability

Record the following:

- a. Data required by MTP 10-2-503.
- b. Location(s) and type(s) of damage(s) to test item container or container contents.
- c. Any damage to the test item or impairment of its operating efficiency. Include details as to location and nature of the fault.

6.3.2.7 Durability

Record data as required by MTP 10-2-502 and any indication of the following:

- a. Fastening failure.

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- b. Loose or missing hardware.
- c. Excessive wear.
- d. Warping and/or distortion.
- e. Damage to any component, material or finish.

6.3.2.8

Maintenance and Reliability Evaluation

Record data as required by the applicable portions of MTP 10-2-507, 10-2-512, and the following:

- a. Maintenance literature which is not easily understood, incomplete or ineffective.
- b. Repair parts which are not proper type or are non-standard.
- c. Ineffective or improperly specified tools.
- d. All applicable data as required to permit the computations as required by Appendix B, USATECOM Regulation 750-15.

6.3.2.9

Safety

Record the following:

- a. Data required by applicable procedures of MTP 10-2-508.
- b. Any dangerous or unsafe condition or any condition that might present a safety hazard including the cause of the hazard.
- c. Safety features incorporated into test item design.
- d. Adequacy of warning instructions and markings.
- e. Suggestions to improve the existing safety precautions.

6.3.2.10

Human Factors Evaluation

Record the following:

- a. Data required by applicable procedures of MTP 10-2-505.
- b. Checklists (complete according to HEDGE criteria).
- c. Noted inadequacies of test item design affecting ease of test item operation.

- d. Recommendations to improve man-item effectiveness.

6.3.2.11 Value Analysis

Record the following:

- a. Nonfunctional, costly, or "nice-to-have" features of test item.
- b. Test personnel comments and opinions regarding features which could be eliminated in accordance with criteria of USATECOM Regulation 700-1.

6.3.2.12 Quality Assurance

Record:

- a. Data required by MTP 10-2-511.
- b. Comments as to any design shortcomings in the area of required quality.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Data Reduction

Organize, analyze and summarize all raw data as specified in each of the MTP's referred to in paragraph 6.2. Use tabulations and charts as appropriate. Make a succinct, unbiased, and independent analysis of test data to show:

- a. The degree to which the test item meets stated requirements (test criteria) in MN or other approved documents.
- b. Deficiencies, shortcomings and suggested improvements.

6.4.2 Data Presentation

Evaluate and present a complete data summary indicating the results and address the following:

- a. Item characteristics such as performance, reliability, durability and human factors engineering.
- b. Comparison of test item characteristics with those of a similar item or standard (control item). Show whether the test item offers a significant improvement (or not) over the control item or only a minimal and perhaps costly improvement.

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c. Maintenance and maintainability characteristics.

d. Safety characteristics and safety recommendation. All aspects of safety must be evaluated to determine if a safety recommendation can be given or must be withheld pending correction of any hazards found.

e. Conclusions and recommendations on overall test objectives and the suitability of the test item for service testing.

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APPENDIX A

	Sarin $\text{CH}_3(\text{C}_2\text{H}_5\text{O})$ FPO GB	VX	Distilled mustard $\text{ClCH}_2\text{CH}_2)_2\text{S}$ HD	Adamsite $\text{NH}(\text{C}_6\text{H}_4)_2$ AsCl DM
Use	Quick action casualty agent	Quick action casualty agent	Delayed action casualty agent	Training and riot control agent
Weight	9,085 lbs/gal	8,412 lbs/gal	10,598 lbs/gal	Solid
State at 20° C.	Colorless liquid	Colorless liquid	Colorless to pale yellow liquid	Yellow to green solid
Odor	Almost none when pure	Odorless	Garlic	None
Rate of detoxifi- cation	Cumulative	Low, essentially cumulative	Very low; cumulative	Rapid in small amounts
Eye and skin toxicity	Very high	Very high	Eyes very susceptible, skin less so	Irritating, relatively nontoxic
Rate of action	Very rapid	Rapid ¹	Delayed, hours to days	Very rapid
Physiolog- ical action	Cessation of breath and death may follow	Produces casualties when inhaled or absorbed	Blisters, de- stroys tissues, injures blood vessels	Cold symptoms plus headache, vomiting and nausea
Protection required	Protective mask and clothing	Protective mask and clothing	Protective mask and clothing	Protective mask
Decontami- nation	In confined area, steam and ammonia; hot soapy water; bleach slurry and dilute alkali solutions	STB, slurry, DANC, or DS2 solution; hot soapy water	Bleach, DANC M5, fire, DS2	None needed in field; bleach or DS2 in confined spaces
Means of detection in the field	M9A2, M10A1, M15A1, M18, M18A1A, M15A2A, and M18A2 kits	M15A1, M18A1A, M15A2A, and M18A2 kits	M9A2, M10A1, M15A1A, M18, M18A1, M15A2A, and M18A2 kits	None

¹VX is a slow-acting lethal nerve agent when absorbed through the skin; however, if inhaled it acts as rapidly as GB and is more toxic.

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APPENDIX A (Cont)

	Chloroaceto- phenone $C_6H_5COCH_2Cl$ CN	Chloroaceto- phenone in chloroform CNC	O-Chlorobenzyl- malononitrile $ClC_6H_4CH(CN)_2$ CS	BZ
Use	Training and riot control agent	Training and riot control agent	Training and riot control agent	Delayed action temporarily incapacitating agent
Weight	Solid	11.686 lbs/gal	Solid	-----
State at 20° C.	Solid	Liquid	Colorless solid	-----
Odor	Apple blossoms	Chloroform	Pepper	None
Rate of detoxifi- cation	Rapid	Rapid	Rapid sublethal in 5 to 10 min.	-----
Eye and skin toxicity	Temporary severe eye irritation, mild skin irritation	Temporary severe eye irritation, mild skin irritation	Highly irritat- ing, nontoxic	-----
Rate of action	Instantaneous	Instantaneous	Instantaneous	Variable
Physiolog- ical action	Lacrimatory; irritates respiratory tract	Lacrimatory; irritates respiratory tract	Highly irritat- ing, montoxic	Dry flushed skin, temperature, tachy- cardia, headache, urinary retention, disorientation, drowsiness, hal- lucinations, giddiness
Protection required	Protective mask	Protective mask	Protective mask	Protective mask
Decontami- nation	Aeration in open; soda ash solution or alcoholic caustic soda in closed spaces	Aeration in open; soda ash solution or alcoholic caustic soda in closed spaces	Water, 5% sodium bisulfite, and water rinse	None
Means of detection in the field	M-Nitrobenzene and alkali in white dot/band tube of de- tector kits	M-Nitrobenzene and alkali in white dot/band tube of de- tector kits	None	None